KILI DRIVE BRIDGE
SOIL EXPLORATION REPORT

MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

TMK: 8-4-2:

To:
MAKAHA VALLEY, INC.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

JANUARY 10, 1975

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

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January 10, 1975

MAKAHA VALLEY, INC.
c/o Sunn, Low, Tom & Hara, Inc.
Pacific Trade Center, Suite 600
190 South King Street
Honolulu, Hawaii 96813

Gentlemen:

Subject: Kili Drive Bridge
Soil Exploration Report
(for foundation design purposes)
Makaha Valley, Waianae, Oahu, Hawaii

Transmitted herewith is our soil exploration report for foundation design purposes for the proposed Kili Drive Bridge at Makaha Valley, Waianae, Oahu, Hawaii.

This report includes a Boring Location Sketch, boring logs, laboratory test results, general foundation design recommendations and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Edward K. Watanabe
Edward K. Watanabe

CM/EKW:rmf

C O N T E N T S

KILI DRIVE BRIDGE
SOIL EXPLORATION REPORT

MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

SCOPE OF EXPLORATION

The purpose of this exploration was to evaluate general soil conditions for foundation design for the proposed Kili Drive Bridge in Makaha Valley, Waianae, Oahu, Hawaii.

This report includes field explorations, laboratory tests, general recommendations for bridge foundation design and limitations.

FIELD EXPLORATION

Six exploratory borings were made at the site. The approximate locations of these borings are shown on the Boring Location Sketch. The borings were made with 4-in. and 14-in. diameter augers using finger type bits. Soil samples were recovered with 2 and 3-in. diameter thin-wall tubes and a 2-in. standard split spoon sampler driven with a 140-lb hammer falling 30 inches.

LABORATORY TESTS

Laboratory tests included: natural water content and density, unconfined compression, laboratory vane shear, Atterberg limit, grain-size analysis, triaxial compression, consolidation and CBR.

SOIL CLASSIFICATION SYSTEM

Soil samples were visually observed and subjected to appropriate tests in the laboratory. Based on visual observations and laboratory tests, the soil descriptions given on the boring logs are generally made in accordance with the "Unified Soil Classification System."

GENERAL SITE CONDITIONS

The site for the proposed bridge is located on Kili Drive about 1,500 ft east of Farrington Highway. The existing Kili Drive is a 24-ft wide paved roadway.

Five, 48-in. diameter pipe culverts cross under Kili Drive on the east side of the proposed bridge site. Water was not noted in the culverts at the time of the field exploration.

The site is generally flat except along the northern edge of the existing roadway where the ground slopes down 2 to 4 ft at about 30% gradients.

Most of the area around the site is covered with grass and brush.

The elevation at the site generally varies from about 30 to 40 ft.

INTERPRETATION OF SOIL CONDITIONS

From the field exploration and laboratory test results, the soils encountered in the borings may be approximated as follows:

A surface layer, about 18 to 38 ft, of varying mixtures of stiff to dense clays and silts mixed with gravels, cobbles and boulders over medium to stiff sandy and clayey silts to about 75 ft, the depth drilled.

Clay (CH) soils were noted in some of the borings at about 9 to 19-ft depths.

Water was noted in the borings at about 25 to 34-ft depths.

Variations to the above soil conditions are to be expected between borings and in localized areas. For more detailed descriptions of soils encountered in the drill holes, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

In general, the proposed plan is to widen Kili Drive, realign the existing stream and remove the existing pipe culverts, and construct a 200-ft long reinforced concrete bridge over the realigned stream.

The bridge consists of two, 29 by 200-ft structures separated by a 14-ft open space. Spans of about 100 ft are anticipated.

A concrete invert slab is planned for the stream bottom.

Cuts of about 5 to 7 ft at the invert level are planned while fills of about 8 to 13 ft are planned at the abutments and roadway.

An existing 15-in. sewer line presently runs under Kili Drive. Due to the proposed excavation at invert level, the sewer line will be relocated to a level below the channel invert. The relocated sewer should be detailed to allow for differential settlements between the utility and the bridge foundations.

Site Grading

General site grading should be done in accordance with the Revised Ordinances of Honolulu, 1969 As Amended and as recommended below:

1. The area should be cleared and grubbed. Surface vegetation and miscellaneous debris should be cleared and removed prior to site filling.

2. Loose surface soils should be stripped to stiff natural ground before the placement of fills. Loose surface soils at finish grade should be scarified and recompacted.

3. Localized soft pockets encountered during the site preparation should be excavated and replaced with compacted select material.

4. In general, fills should be laid in 6-in. compacted layers to 90% of the maximum density determined by the AASHO T-180-73I test method. In roadway areas, the top 2 ft of fill should be compacted to 95% of the maximum density.

5. Provisions to drain the site should be included during and after the completion of filling operations.

6. To minimize erosion, the side slopes and bottom of the stream should be lined.

7. Where fills are proposed in natural drainageways, loose material at the bottoms and sides should be stripped down to stiff natural ground before the placement of fills.

   Subdrains should be placed along the bottoms of natural drainageways with laterals in a herringbone pattern along the sides of the drainageways.

Foundations

From the field exploration, the subsurface soils may be generally described as a surface layer, about 18 to 38 ft of varying mixtures of stiff to dense clays and silts mixed with gravels, cobbles and boulders over medium to stiff sandy and clayey silts to 75 ft, the depth drilled.

For the proposed bridge structures, spread or continuous footing foundations resting on the stiff to dense surface layer of bouldery clay may be considered with the understanding that settlements of several inches may eventually occur. Much of the anticipated settlements will probably be due to the clays and silts with high water contents that underlie the bouldery surface deposits.

Friction pile foundations extending into the medium to stiff underlying sandy and clayey silt layer may be considered. However, even with friction pile foundations, settlements will probably occur. The anticipated settlements with piles may be about one-half of those estimated under spread footings.

If practicable, simple spans should be used to minimize the effects of differential settlements.

Spread footing foundations

For spread footings resting on the stiff to dense bouldery clay layer, bearing values of 3000 p.s.f. may be used.

The footings should be protected against undermining from erosion. The footings should extend several feet below the invert of the channel and theoretically below the depth of scour. Otherwise, the bottom of the channel should be lined and the lining extended beyond the footings.

Loose, soft or clay pockets encountered in footing excavations should be removed and replaced with select on-site or well-graded granular material compacted in thin level layers.

Pile foundations

Friction pile foundations extending thru the bouldery clay surface layer into the underlying medium to stiff soils may be considered.

Twelve-in. by 12-in. prestressed concrete piles extending about 50 ft below the concrete channel invert may be used.

Allowable loads of about 30 tons per pile may be used.

Predrilling or spudding may be required to penetrate the bouldery clay surface.

The piles should be placed as far apart as practicable and generally not less than 3 ft on centers.

The pile driving contractor should observe that piles already in place are not heaved upward during pile driving. Any pile that has been heaved upward should be redriven to its original position.

Abutments

If practicable, retaining wall type abutments should be avoided. Spill-thru type abutments are preferable.

Lateral design earth pressures approximating at-rest conditions of about 45 p.c.f. for walls unrestrained at the top and 60 p.c.f. for walls restrained at the top are recommended. In addition, lateral pressures due to surcharge or live loads should be included to act on the abutments. The center of pressure

should be considered to act somewhat above the lower third of the triangular fluid pressure diagram. This assumes that drainage of the backfill is provided.

Bridge Approaches

To minimize differential settlements between the bridge and approaches, the backfill behind the abutments should be made with granular material. The backfill should be placed in thin level lifts and well compacted. If practicable, the approaches to the bridge should be surcharged during the construction period and the pavement work in these areas delayed as long as practicable. An alternate method is to construct an approach slab.

Underground Utilities

Underground utilities should be placed after the fills are constructed. Utilities should be designed with flexible joints, particularly where lines cross the abutments.

Unforeseen Conditions

Because of the variability of soil deposits, site improvements, designs and construction techniques, conditions may be encountered that cannot be foreseen with even the most exhaustive studies of site and project conditions. These unforeseen conditions should

be recognized when encountered and then evaluated so that the designs or the construction methods may be modified accordingly if necessary.

Unforeseen or undetected conditions such as soft spots, existing utility trenches, underground structures, voids or cavities, boulders, expansive soil pockets or seepage water, etc., may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.

BORING LOGS

The stratification lines shown on each of the boring logs represent the approximate boundary between soil types and the transition may be gradual.

Symbols

Symbols used generally are in accordance with the Unified Soil Classification System.

Where a parenthesis "(MH)" is used, the soil sample was classified by visual observation of the sample recovered.

Where no parenthesis "MH" is used, the soil sample was classified from either the Atterberg limit or grain-size analysis test results.

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT KILI DRIVE BRIDGE
LOCATION Makaha Valley, Waianae, Oahu, Hawaii
HAMMER: Weight 140# Drop 30"
SAMPLER: 2"S - 2"O.D. THIN WALL TUBE; 2"SS - 2" STANDARD SPLIT SPOON

BORING NO. 1 Sheet No. ____ of ____
Driller W. LUM ASSOC., INC. Date NOV. 26, 1974
Field Party KAKU, KAU, ORITA
Type of Boring AUGER (MOBILE B-40) Diam. 4"
Elev. 34'± * Datum —
Drill Bit FINGER TYPE
Water Level 30.0'
Time 3:05 P.M.
Date 11-26-74

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test / 2"O.D. THIN WALL TUBE SAMPLER — N (Blows per foot) 0 10 20 30 40 — BLOWS/0.5'
	ELEV. = 37'± *	0								
(GM)	DENSE, BROWN SILTY GRAVEL W/SAND		2"SS	1-A	-	12	-	-	-	46
			2"SS	1-B	-	9	-	-	-	42/0.5'
	COBBLE OR BOULDER	5								
(GM)	DENSE, GRAY BROWN SILTY GRAVEL W/SAND		2"SS	1-C	-	7	-	-	-	40/0.5'
	COBBLE OR BOULDER									
		10								
CH	STIFF, BROWN CLAY W/SAND		2"SS	1-D	25	27	76	-	-	
	COBBLE OR BOULDER									
		15	2"SS	1-E	NO RECOVERY					30/0.1' HAMMER BOUNCES
(SM)	DENSE, BROWN SILTY SAND W/GRAVEL	20	2"SS	1-F	-	12	-	-	-	40/0.4' HAMMER BOUNCES
(ML)	STIFF, BROWN SANDY SILT	25	2"SS	1-G	-	42	-	-	-	54
			WATER 11-26-74							
SM	DENSE, MOTTLED BROWN SILTY SAND	30	2"S	1-H	-	41 γ_w=107 γ_D=76	-	1680	-	5/0.5' 10/0.5'
		35	2"SS	1-I	-	55	-	-	-	
(ML)	STIFF, BROWN SANDY SILT									
		40	2"S	1-J	-	56 γ_w=106 γ_D=68	-	500	-	1/0.5' 3/0.5' 4/0.5'
		45								
(MH)	MEDIUM TO STIFF BROWN, SANDY SILT		2"SS	1-K	-	59	-	-	-	
(ML-MH)	MEDIUM TO STIFF BROWN, SANDY SILT	50								
			2"SS	1-L	-	50 / 37	-	-	-	
(MH-CH)	STIFF, BROWN SILTY CLAY									
	END OF BORING @ 51.5' 11-26-74									

NOTE:
γ_w = WET DENSITY, P.C.F.
γ_D = DRY DENSITY, P.C.F.

* ELEVATION ESTIMATED FROM TOPO MAP

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT: KILI DRIVE BRIDGE
LOCATION: Makaha Valley, Waianae, Oahu, Hawaii

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: 2"SS - 2" O.D. THIN WALL TUBE; 2"SS - 2" STANDARD SPLIT SPOON

BORING NO. 2 Sheet No. ____ of ____
Driller: W. LUM ASSOC., INC. Date: NOV. 22 & 25, 1974
Field Party: ASATO, KAU, ORITA, KAKU
Type of Boring: AUGER (MOBILE B-40) Diam.: 14" & 4"
Elev.: 36'± * Datum: —
Drill Bit: FINGER TYPE

Water Level	33.0'	33.5'			
Time	—	1:20 PM			
Date	11-21-74	11-25-74			

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test N (Blows per foot) 0 10 20 30 40	PENETRATION DATA: 2" O.D. THIN WALL TUBE SAMPLER BLOWS/0.5'
	ELEV. = 36'± *	0									
	AUGER 14"										
(GM)	MEDIUM DENSITY, BROWN GRAVEL W/SILTY SAND	5	2"SS	2-A	—	11	—	—	—		
	AUGER 4"	10	2"SS	2-B	—	10 26	—	—	—		
(CH)	STIFF, BROWN CLAY	15	2"SS	2-C	—	7	—	—	—		45/0.5'
	DENSE, GRAVEL, COBBLES OR BOULDERS	20	2"SS	2-D	ROCK FRAGMENTS						30/0.1'
(MH)	STIFF, BROWN SILTY CLAY W/GRAVEL	25	2"SS	2-E	—	19 9	—	—	—		50/0.5'
	DENSE, GRAVEL COBBLES OR BOULDERS W/SILTY SAND										
(ML-MH)	MEDIUM, MOTTLED BROWN SANDY SILT	30	2"SS	2-F	—	53	—	—	—		
			WATER 11-25-74								
(GM)	DENSE, MOTTLED BROWN SILTY GRAVEL W/SAND	35	2"SS	2-G	—	26 41	—	—	—		
(ML-MH)	STIFF, BROWN SANDY SILT W/TRACES OF GRAVEL										
(SM)	DENSE, MOTTLED BROWN SILTY SAND W/GRAVEL	40	2"S	2-H	—	43	—	—	—		15/0.5'
		45									
MH	STIFF, BROWN CLAYEY SILT W/SAND		2"SS	2-I	35	51	57	—	—		
		50	2"SS	2-J	—	55	—	—	—		
	END OF BORING @ 51.5 11-25-74										

* ELEVATION ESTIMATED FROM TOPO MAP

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT: KILI DRIVE BRIDGE
LOCATION: Makaha Valley, Waianae, Oahu, Hawaii

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: 2"SS - 2" O.D. THIN WALL TUBE; 2"SS - 2" STANDARD SPLIT SPOON; 3"S - 3" O.D. THIN WALL TUBE

BORING NO. 3 Sheet No. ____ of ____
Driller: W. LUM ASSOC., INC. Date: NOV. 27, 1974
Field Party: KAKU, KAU, ORITA
Type of Boring: AUGER (MOBILE B-40) Diam.: 4"
Elev.: 35'± * Datum: —
Drill Bit: FINGER TYPE
Water Level: 32.0'
Time: 1:30 PM
Date: 11-27-74

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test (N, Blows per foot) / 2" & 3" O.D. THIN WALL TUBE SAMPLER (BLOWS/0.5')
	ELEV. = 35'± *	0								
(ML)	STIFF, BROWN CLAYEY SILT W/TRACES OF SAND, GRAVEL & ROOTS		2"SS	3-A	—	13	—	—	—	20/0.3'
	COBBLE OR BOULDER									
(GM)	DENSE, GRAY & BROWN SILTY GRAVEL W/ SAND	5	2"SS	3-B	—	5	—	—	—	31/0.3'
	COBBLE OR BOULDER	10								
(CH)	STIFF, MOTTLED BROWN CLAY W/TRACES OF SAND & GRAVEL		2"SS	3-C	—	26	—	—	—	
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/ DECOMPOSED ROCK & SAND	15	2"SS	3-D	—	18	—	—	—	40/0.5'
(ML)	STIFF MOTTLED TAN BROWN SANDY SILT	20	2"S	3-E	—	27 γ_W = 93 γ_D = 73	—	—	—	6/0.5' 9/0.5'
(ML)	STIFF, MOTTLED BROWN SANDY SILT	25	2"SS	3-F	—	40	—	—	—	50/0.4' HAMMER BOUNCES
	COBBLE OR BOULDER									
ML	STIFF, BROWN SANDY SILT	30	3"S WATER 11-27-74	3-G	30	39 γ_W = 94 γ_D = 68	48	—	—	9/0.5' 11/0.2'
		35	2"SS	3-H	—	54	—	—	—	
(MH)	STIFF, BROWN SANDY SILT	40	3"S	3-I	—	56 γ_W = 108 γ_D = 69	—	—	—	4/0.5' 6/0.5'
(MH)	BROWN, CLAYEY SILT	45								
(MH)	STIFF, BROWN W/GRAY CLAYEY SILT		2"SS	3-J	—	66 53 36	—	—	—	
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/TRACES OF SAND									
	END OF BORING @ 46.5' 11-27-74									

NOTE:
γ_W = WET DENSITY, P.C.F.
γ_D = DRY DENSITY, P.C.F.

* ELEVATION ESTIMATED FROM TOPO MAP

KILI BRIDGE

WALTER LUM ASSOCIATES, INC. ■ 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT: KILI DRIVE BRIDGE
LOCATION: Makaha Valley, Waianae, Oahu, Hawaii

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: 2"ss - 2"O.D. THIN WALL TUBE; 2"ss - 2" STANDARD SPLIT SPOON

BORING NO. 4 Sheet No. ____ of ____
Driller: W. LUM ASSOC., INC. Date: Nov. 19-21, 1974
Field Party: KAKU, ASATO, ORITA, KAU
Type of Boring: AUGER (MOBILE B-40) Diam.: 4"
Elev.: 35'± * Datum: —
Drill Bit: FINGER TYPE
Water Level: 33.0'± Time: — Date: 11-21-74

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test N (Blows per foot) 0 10 20 30 40	PENETRATION DATA: 2"O.D. THIN WALL TUBE SAMPLER BLOWS/0.5'
	ELEV. = 35'± *	0									
(ML)	STIFF, BROWN CLAYEY SILT W/ SAND & DECOMPOSED ROCK		2"SS	4-A	–	11	–	–	–		46
			2"SS	4-B	–	15	–	–	–		
	COBBLES OR BOULDERS	5									
(GM)	DENSE, MOTTLED BROWN SILTY GRAVEL, SAND & DECOMPOSED ROCK		2"SS	4-C	–	8	–	–	–		35/0.5' HAMMER BOUNCES
	COBBLES OR BOULDERS										
(SM)	DENSE, MOTTLED BROWN SILTY SAND W/GRAVEL & DECOMPOSED ROCK		2"SS	4-D	–	13	–	–	–		43
	COBBLES OR BOULDERS	15									
(ML)	STIFF, BROWN SANDY SILT		2"SS	4-E	–	24	–	–	–		54
(SM)	DENSE, BROWN SILTY SAND W/GRAVEL, CEMENTED SAND & DECOMPOSED ROCK	20	2"SS	4-F	–	16	–	–	–		37/0.5
	COBBLES										
(SM)	DENSE, BROWN SILTY SAND W/GRAVEL	25	2"SS	4-G	–	36	–	–	–		40
(ML-MH)	STIFF, MOTTLED BROWN SANDY SILT W/TRACES OF GRAVEL	30	2"SS	4-H	–	64	–	–	–		
			WATER 11-21-74								
(ML)	STIFF, BROWN SANDY SILT	35	2"SS	4-I	–	40	–	–	–		

	COBBLES OR BOULDERS	40										
(ML)	STIFF, BROWN SANDY SILT W/ GRAVEL	45	2"SS	4-J	-	56	-	-	-			
(ML-MH)	STIFF BROWN SANDY SILT W/ DECOMPOSED ROCK	50	2"SS	4-K	-	47	-	-	-			
			2"SS	4-L	-	57	-	-	-			
(MH)	STIFF MOTTLED BROWN SANDY SILT W/ DECOMPOSED ROCK	55	2"SS	4-M	-	61	-	-	-			
	BROWN DECOMPOSED PUKA ROCK	60	2"SS	4-N	-	56	-	-	-			
		65										
(MH)	STIFF, BROWN CLAYEY SILT		2"SS	4-O	-	56	-	-	-			
		70	2"SS	4-P	-	54	-	-	-			
SM	MEDIUM DENSITY BROWN, SILTY SAND	75	2"S	4-Q	-	52	-	-	-			$^{5}/_{0.5}$' $^{7}/_{0.5}$' $^{13}/_{0.5}$
	END OF BORING @ 76.5' 11-21-74											

* ELEVATION ESTIMATED FROM TOPO MAP

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT: KILI DRIVE BRIDGE
LOCATION: Makaha Valley, Waianae, Oahu, Hawaii
HAMMER: Weight 140# Drop 30"
SAMPLER: 2" SS - 2" O.D. THIN WALL TUBE; 2" SS - 2" STANDARD SPLIT SPOON; 3" S - 3" O.D. THIN WALL TUBE

BORING NO. 5 Sheet No. ____ of ____
Driller W. LUM ASSOC, INC. Date NOV. 29 & DEC. 2, 1974
Field Party KAKU, KAU, HEW, LEE
Type of Boring AUGER (MOBILE B-40) Diam. 4"
Elev. 32'± * Datum —
Drill Bit FINGER TYPE

Water Level	25.5'	26'			
Time	1:25PM	3:10PM			
Date	12-2-74	11-29-74			

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test; 2" & 3" O.D. THIN WALL TUBE SAMPLER; N (Blows per foot) 0 10 20 30 40; BLOWS/0.5'
	ELEV. = 32'± *	0								
(GM)	DENSE, MOTTLED BROWN SILTY SAND & GRAVEL		2"SS	S-A	—	11	—	—	—	60
	COBBLE OR BOULDER	5								
(GM)	GRAY BROWN PUKA PUKA ROCK W/TRACES OF BROWN SILTY SAND		2"SS	S-B	—	7	—	—	—	
(CH)	STIFF, MOTTLED BROWN CLAY	10	2"S	S-C	—	24	—	8310	—	9/0.5' 6/0.5'
						γ_W = 104				
						γ_D = 84				
	COBBLE OR BOULDER									
(CH)	STIFF, BROWN CLAY	15								
(MH-CH)	STIFF, MOTTLED BROWN SILTY CLAY W/DECOMPOSED ROCK		2"SS	S-D	—	15 19	—	—	—	68
		20								
(SM)	MEDIUM DENSITY MOTTLED BROWN SILTY SAND W/ GRAVEL		2"SS	S-E	—	53	—	—	—	
	WATER 11-29-74	25	3"S	S-F	—	58	—	—	—	3/0.5' 4/0.5'
						γ_W = 105				
						γ_D = 66				
	MEDIUM-STIFF MOTTLED BROWN	30								
(ML-MH)	SANDY SILT		2"SS	S-G	—	55	—	—	—	
		35								
			2"S	S-H	—	61 57	—	550	400 460	2/0.5' 3/0.5' 4/0.5'
						γ_W = 107				
(MH)	STIFF LIGHT BROWN W/BROWN CLAYEY SILT W/TRACES OF SAND	40	2"SS	S-I	—	44	—	—	—	
		45								
			2"SS	S-J	—	47	—	—	—	
MH	STIFF, BROWN SANDY SILT									
		50								
			3"S	S-K	32	51	52	—	—	6/0.5' 10/0.5'
						γ_W = 110				
						γ_D = 73				
	END OF BORING @ 51' 12-2-74									

* ELEVATION ESTIMATED FROM TOPO MAP

NOTE:
γ_W = WET DENSITY, P.C.F.
γ_D = DRY DENSITY, P.C.F.

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT: KILI DRIVE BRIDGE
LOCATION: Makaha Valley, Waianae, Oahu, Hawaii

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: 2"SS - 2" O.D. THIN WALL TUBE; 2"SS - 2" STANDARD SPLIT SPOON; 3"S - 3" O.D. THIN WALL TUBE

BORING NO. 6 Sheet No. ____ of ____
Driller W. LUM ASSOC, INC. Date DEC. 2 & 3, 1974
Field Party KAKU, LEE, HEW
Type of Boring AUGER (MOBILE B-40) Diam. 4"
Elev. 34 ± * Datum —
Drill Bit FINGER TYPE

Water Level	28.5'				
Time	3:15 PM				
Date	12-3-74				

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test, N (Blows per foot) 0 10 20 30 40
	ELEV. = 34' ± 7 * 0									
(ML-MH)	STIFF, MOTTLED BROWN SILTY CLAY W/GRAVEL & DECOMPOSED ROCK		2"SS	G-A	–	12	–	–	–	68
			2"SS	G-B	–	14	–	–	–	40/0.4'
	COBBLE OR BOULDER									HAMMER BOUNCES
		5								
(ML)	STIFF, BROWN CLAYEY SILT W/TRACES OF SAND		2"SS	G-C	–	15	–	–	–	
		10								
(SM)	MEDIUM DENSITY TO DENSE BROWN, SILTY SAND		2"S	G-D	–	13 γ_W = 91 γ_D = 81	–	–	–	3/0.5' 2/0.5' 4/0.5'
		15								
(GM)	DENSE, BROWN SILTY GRAVEL W/SAND		2"SS	G-E	–	18 24	–	–	–	
(ML)	STIFF, BROWN CLAYEY SILT W/GRAVEL	20	3"S	G-F	–	16	–	–	–	13/0.5'
	COBBLE									
(ML)	STIFF, MOTTLED BROWN CLAYEY SILT	25	2"SS	G-G	–	32 35 50	–	–	–	
	GRAY BROWN, GRAVEL OR COBBLES W/CLAYEY SILT									
(ML)	STIFF, MOTTLED BROWN SANDY SILT		WATER 12-3-74							
		30	2"SS	G-H	–	29	–	–	–	30/0.3'
	COBBLE OR BOULDER									HAMMER BOUNCES
(ML-MH)	STIFF, MOTTLED BROWN CLAYEY SILT W/SOME GRAVEL	35	2"SS	G-I	–	38	–	–	–	52
(ML-MH)	MEDIUM-STIFF, BROWN CLAYEY SILT W/SAND & DECOMPOSED ROCK	40	3"S	G-J	–	48 γ_W = 111 γ_D = 75	–	670	–	6/0.5' 8/0.5'
		45								
(MH)	MEDIUM-STIFF, BROWN CLAYEY SILT W/SAND & GRAVEL		2"SS	G-K	–	50	–	–	–	
(MH)	MEDIUM-STIFF, BROWN CLAYEY SILT W/SAND & TRACES OF DECOMPOSED ROCK	50	2"SS	G-L	–	59	–	–	–	
	END OF BORING @ 51.5' 12-3-74									

NOTE:
γ_W = WET DENSITY, P.C.F.
γ_D = DRY DENSITY, P.C.F.

* ELEVATION ESTIMATED FROM TOPO MAP

KILI DRIVE BRIDGE

TABLE I A - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	1	1	1	2
SAMPLE NO.	D	H	K	I
DEPTH BELOW SURFACE	10'-11.5'	30'-31'	45'-46.5'	45'-46.5'
DESCRIPTION	BROWN CLAY W/SAND	MOTTLED BROWN SILTY SAND	BROWN SANDY SILT	BROWN CLAYEY SILT W/SAND
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1"		100	100	
1/2"		100	100	
#4		100	100	
#10		100	99.8	
#20		99.6	98.0	
#40		92.1	91.0	
#100		58.4	64.7	
#200		48.1	54.4	
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL			NATURAL
Liquid Limit	76			57
Plastic Limit	25			35
Plasticity Index	51			22
Dilatancy	NONE			SLOW-MED.
Toughness	HIGH			MEDIUM
Dry Strength	HIGH			MEDIUM
UNIFIED SOIL CLASSIFICATION	CH	SM	MH	MH
APPARENT SPECIFIC GRAVITY				
CBR TEST (Surcharge-51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-73I, Method ___)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 1-6-75 By RT

3-1273

KILI DRIVE BRIDGE

TABLE I B - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.		3		4	4
SAMPLE NO.		G			Q
DEPTH BELOW SURFACE		30'-30.7'		SURFACE	75'-76.5'
DESCRIPTION		BROWN SANDY SILT		BROWN CLAYEY SAND W/GRAVEL	BROWN SILTY SAND
GRAIN-SIZE ANALYSIS (% Passing)					
Sieve	1½"			91.1	100
	1"			88.1	100
	1/2"			74.3	100
	#4			62.8	100
	#10			53.2	99.7
	#20			40.7	99.1
	#40			30.7	89.6
	#100			21.7	55.1
	#200			19.4	47.1
ATTERBERG LIMITS					
Air Dried or Natural		NATURAL		NATURAL	
Liquid Limit		48		34	
Plastic Limit		30		23	
Plasticity Index		18		11	
Dilatancy		MEDIUM		MED.-QUICK	
Toughness		SLIGHT-MED.		MEDIUM	
Dry Strength		SLIGHT-MED		SLIGHT-MED	
UNIFIED SOIL CLASSIFICATION		ML		SC	SM
APPARENT SPECIFIC GRAVITY		2.81			
CBR TEST (Surcharge-51 P.S.F.)					
Molding Moisture, %				13.7	
Molding Dry Density, P.C.F.				124.8	
Swell upon saturation, %				0.2	
CBR at 0.1" Penetration				82.0	
MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-73I, Method ___)					
Dry to Wet or Wet to Dry					
Max. Dry Density (P.C.F.)					
Optimum Moisture (%)					

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 1-6-75 By BT

3-1273

KILI DRIVE BRIDGE

TABLE I C - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	5	5		
SAMPLE NO.	F	K		
DEPTH BELOW SURFACE	25'-26'	50'-51'		
DESCRIPTION	BROWN SANDY SILT	BROWN SANDY SILT		
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1"				
1/2"				
#4				
#10				
#20				
#40				
#100				
#200				
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL	NATURAL		
Liquid Limit		52		
Plastic Limit	NON-PLASTIC	32		
Plasticity Index		20		
Dilatancy		SLOW-MED.		
Toughness		MEDIUM		
Dry Strength		SLIGHT-MED.		
UNIFIED SOIL CLASSIFICATION		MH		
APPARENT SPECIFIC GRAVITY				
CBR TEST (Surcharge-51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS				
(AASHO T-180-73I, Method ___)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

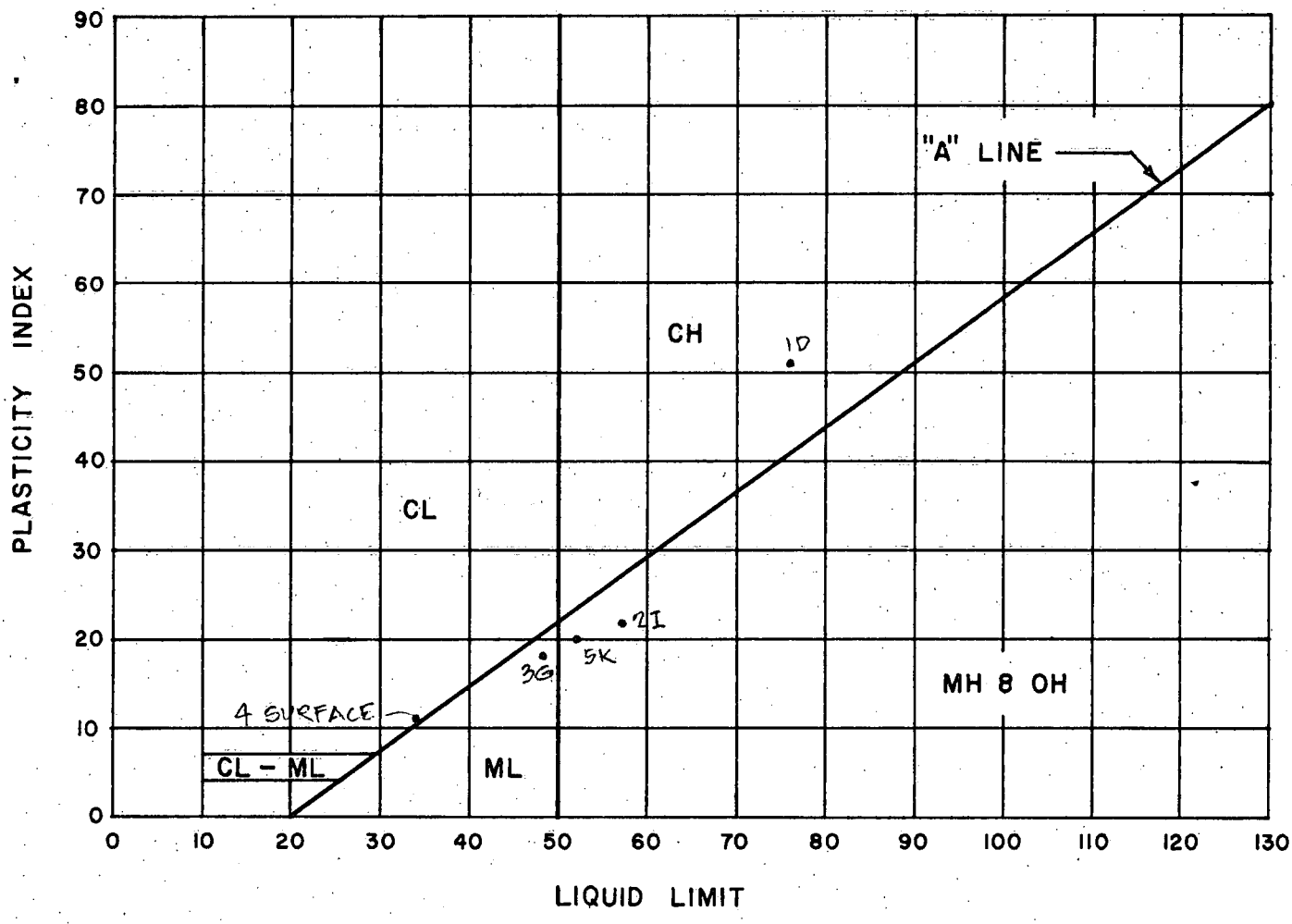
WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 1-6-75 By BT

PLASTICITY CHART

PROJECT: KILI DRIVE BRIDGE

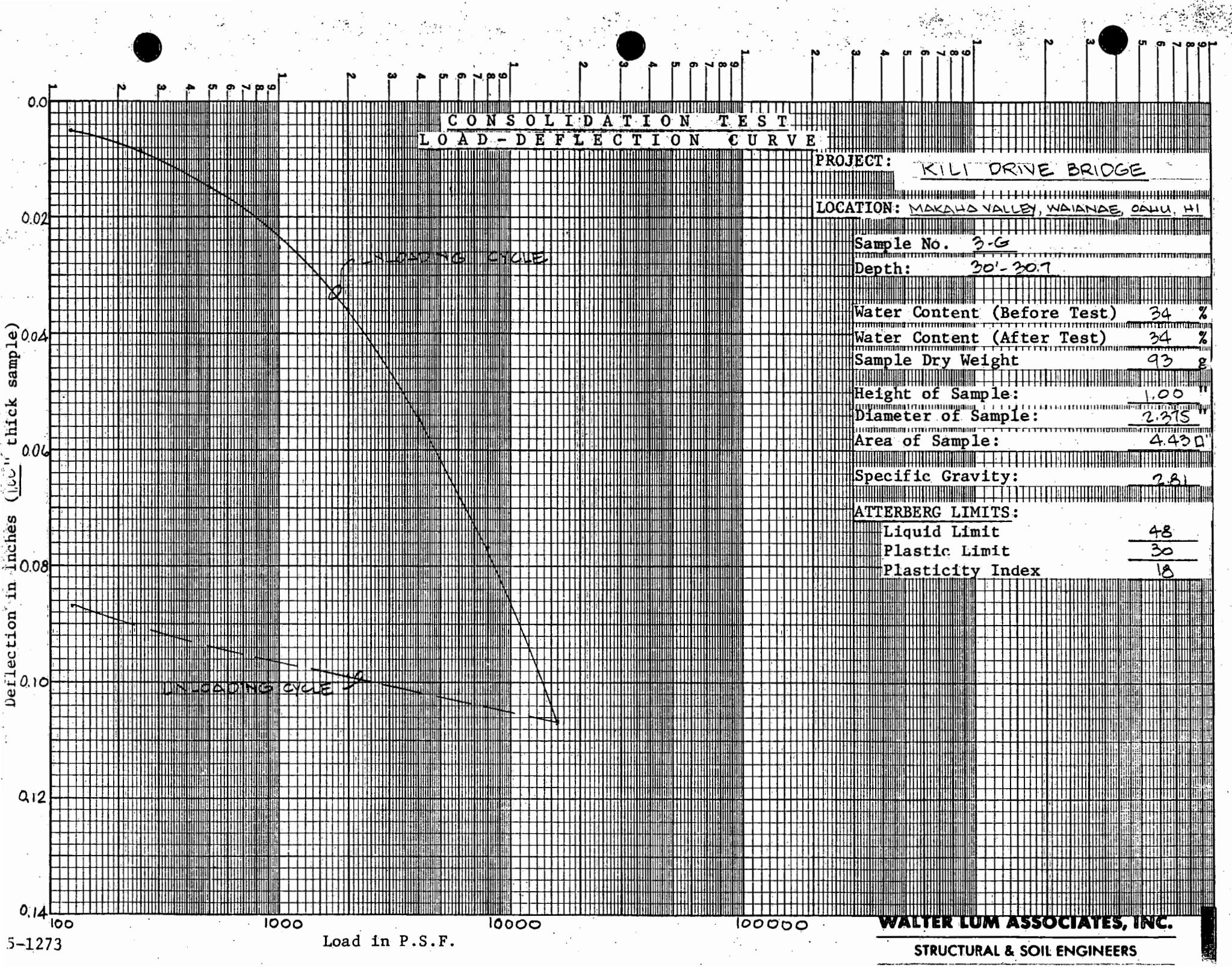
LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HAWAII



DATE 1-6-75 BY PDT

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

CONSOLIDATION TEST
LOAD-DEFLECTION CURVE



PROJECT: KILI DRIVE BRIDGE

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HI

Sample No.	3-G
Depth:	30'-30.7
Water Content (Before Test)	34 %
Water Content (After Test)	34 %
Sample Dry Weight	93 g
Height of Sample:	1.00 "
Diameter of Sample:	2.375 "
Area of Sample:	4.430
Specific Gravity:	2.81

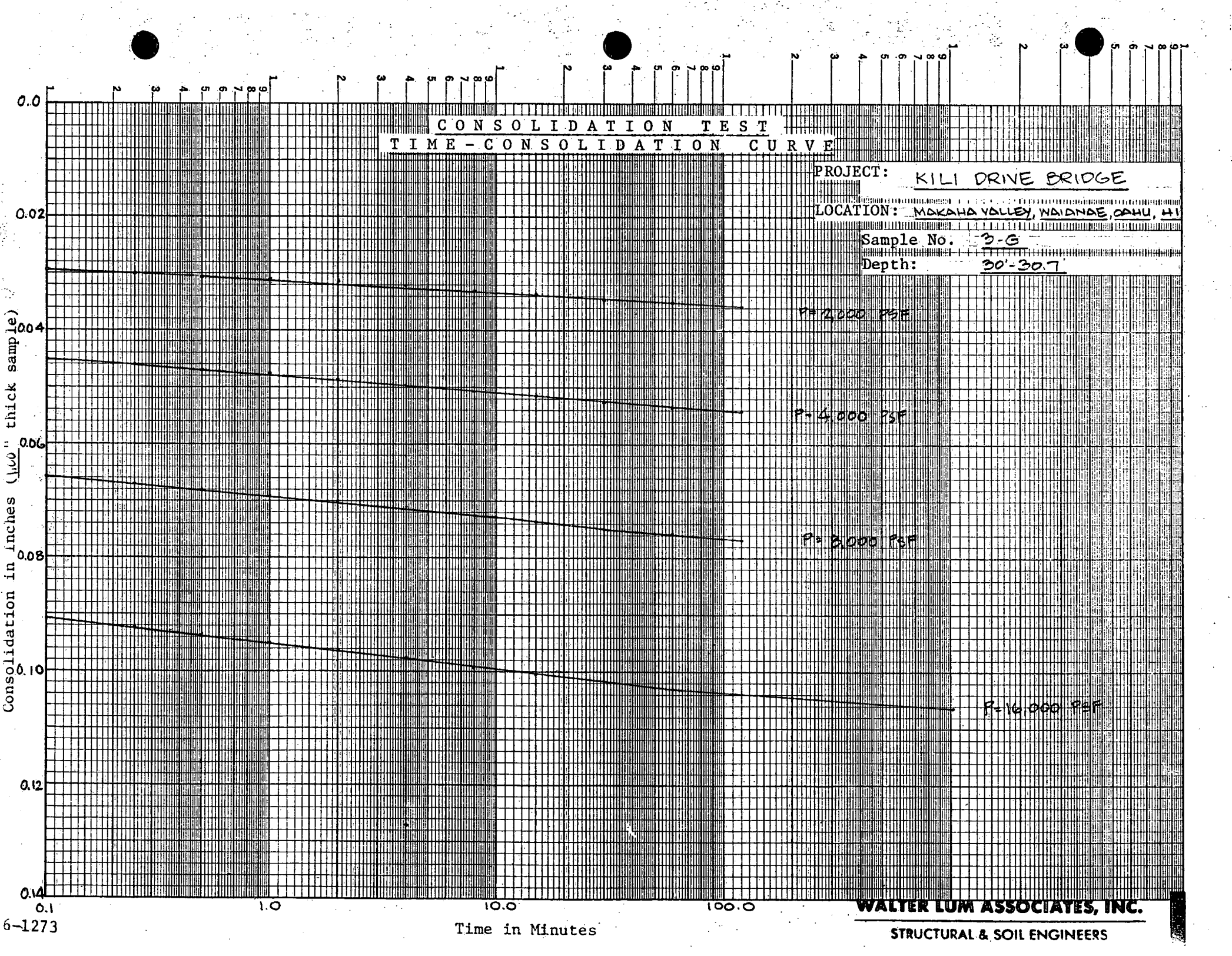
ATTERBERG LIMITS:

Liquid Limit	48
Plastic Limit	30
Plasticity Index	18

5-1273

WALTER LUM ASSOCIATES, INC.

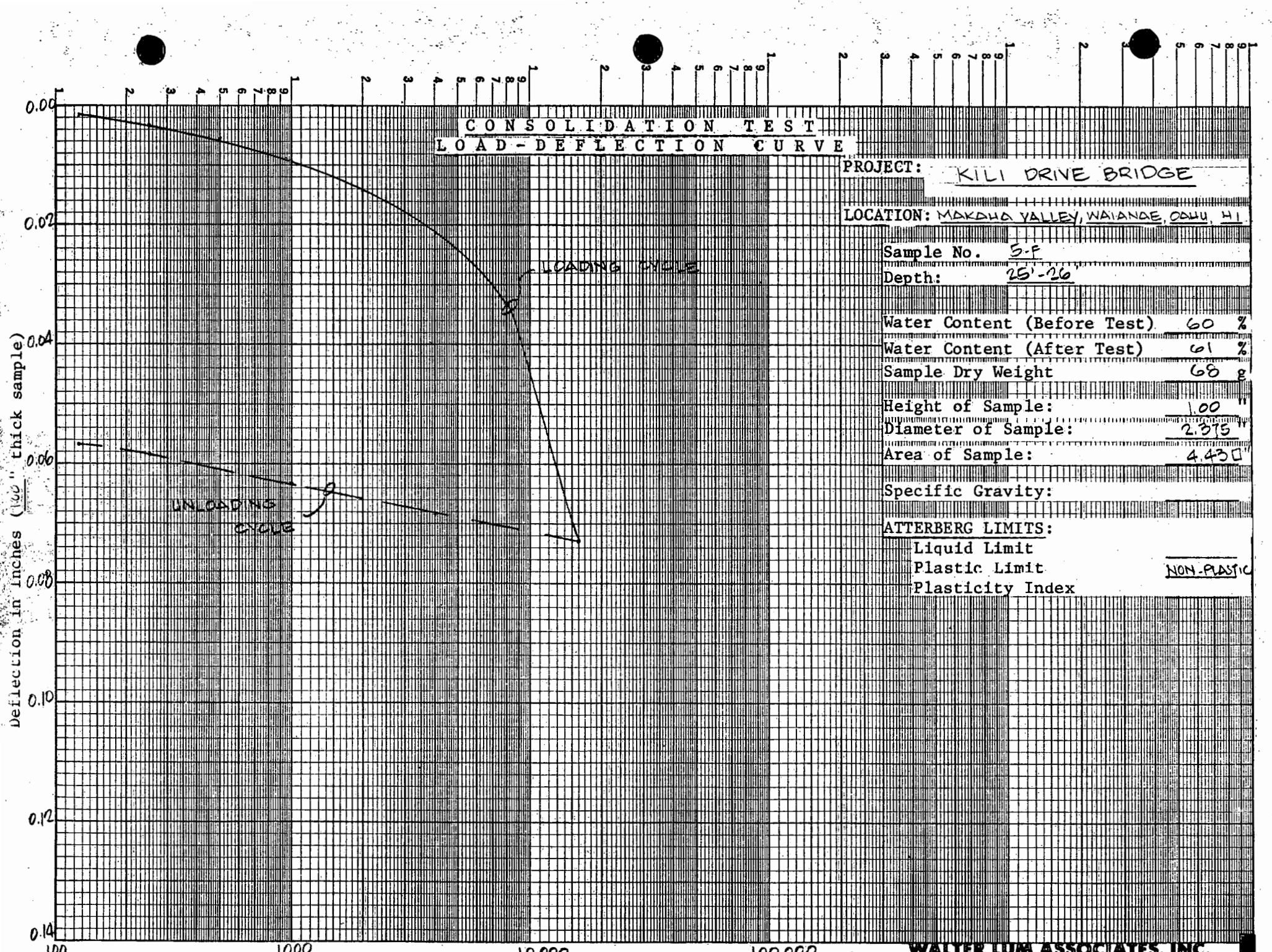
STRUCTURAL & SOIL ENGINEERS



WALTER LUM ASSOCIATES, INC.
STRUCTURAL & SOIL ENGINEERS

6-1273

CONSOLIDATION TEST
LOAD-DEFLECTION CURVE



PROJECT: KILI DRIVE BRIDGE

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HI

Sample No.	S-F
Depth:	25'-26'
Water Content (Before Test)	60 %
Water Content (After Test)	61 %
Sample Dry Weight	68 g
Height of Sample:	1.00 "
Diameter of Sample:	2.375 "
Area of Sample:	4.430"
Specific Gravity:	

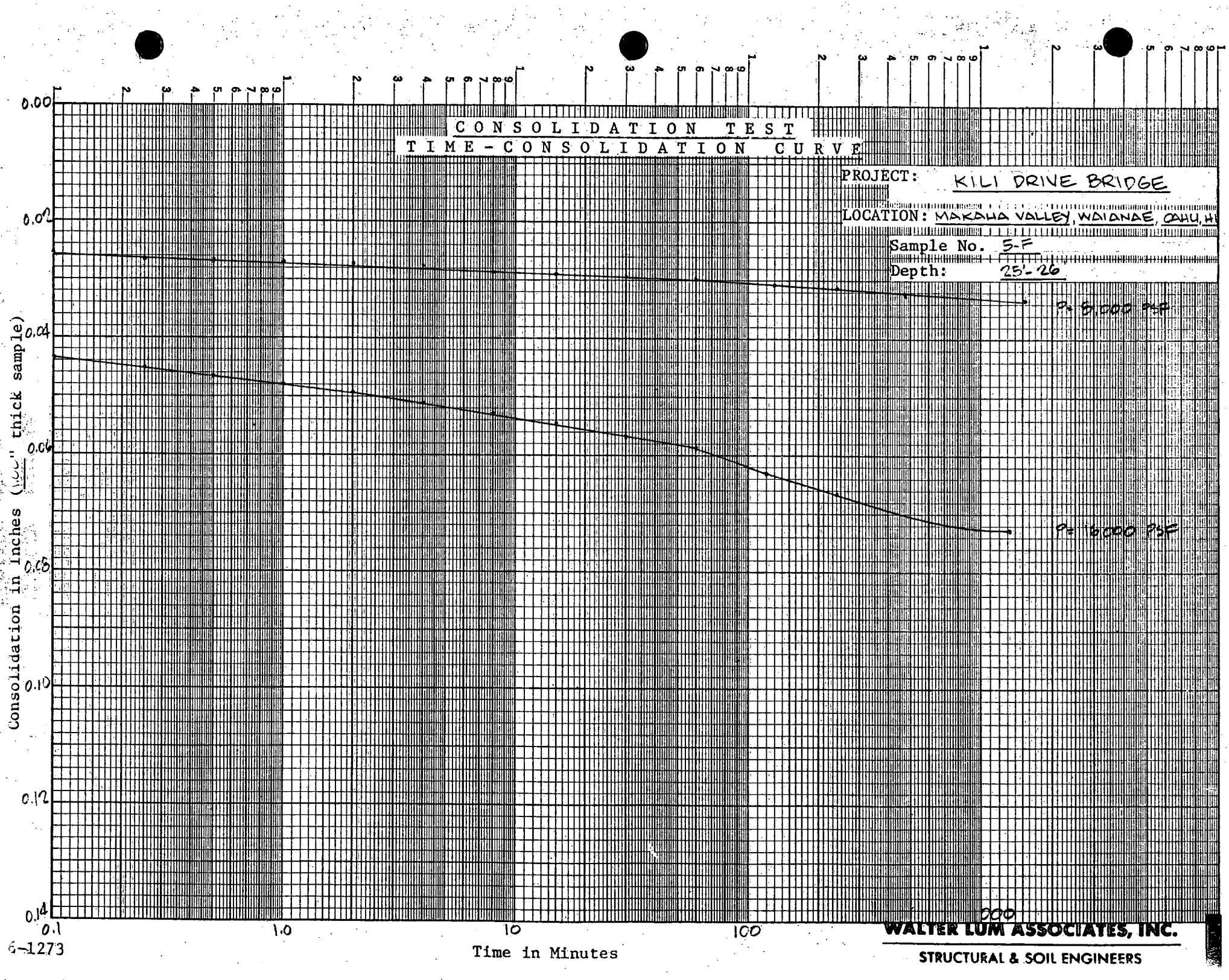
ATTERBERG LIMITS:

Liquid Limit	
Plastic Limit	NON-PLASTIC
Plasticity Index	

5-1273

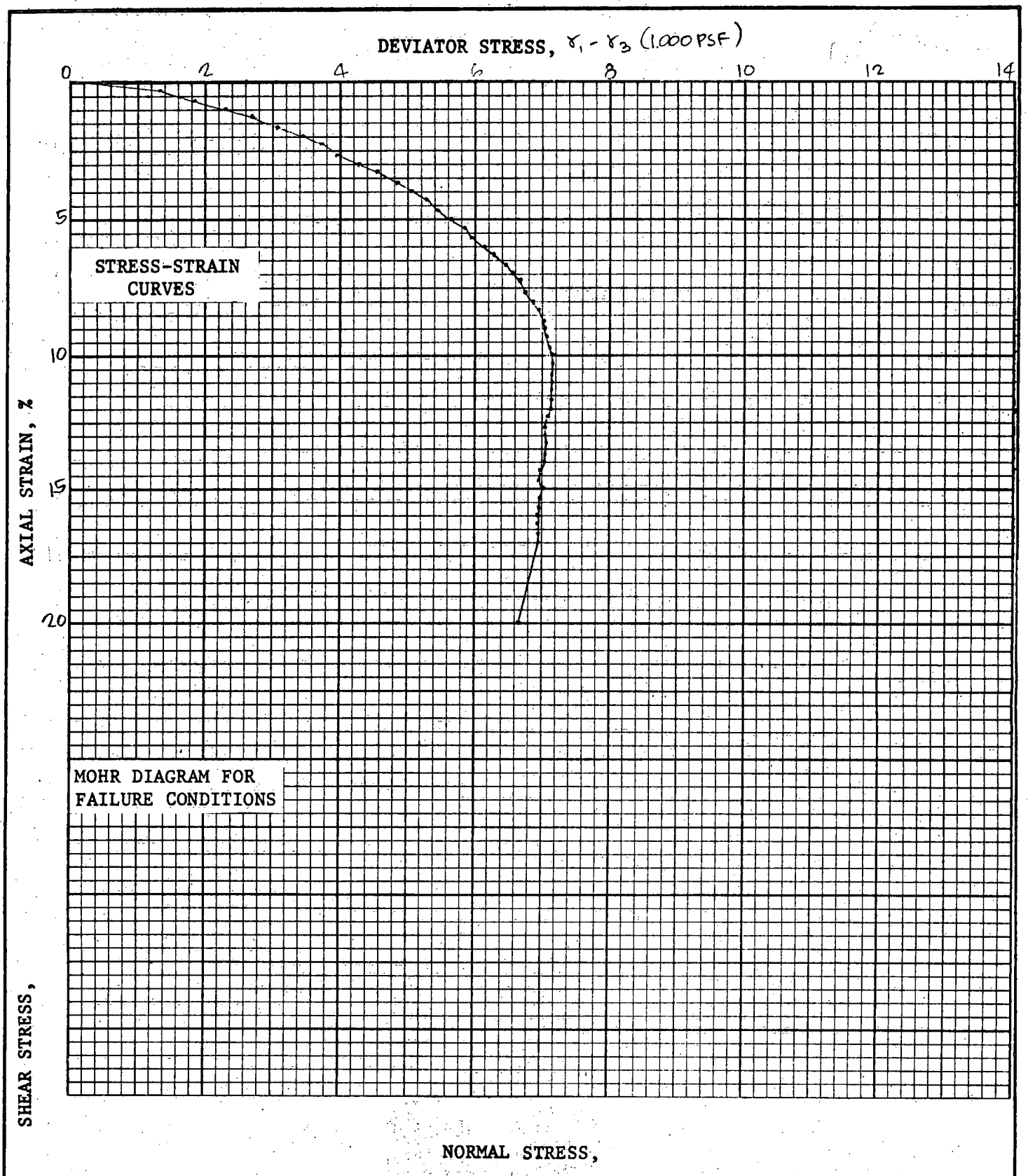
WALTER LUM ASSOCIATES, INC.

STRUCTURAL & SOIL ENGINEERS



WALTER LUM ASSOCIATES, INC.
STRUCTURAL & SOIL ENGINEERS

6-1273



SAMPLE DESCRIPTION	SAMPLE SIZE	ATTERBERG LIMITS	REMARKS
BROWN SANDY SILT	2⅞" X 6"	LL= 52 PL= 32 PI = 20	

KILI DRIVE BRIDGE
Makaha Valley, Waianae, Oahu, Hawaii

KEY	BORING NO.	SAMPLE NO.	DEPTH	TEST TYPE	LATERAL PRESSURE P.S.F.	DEVIATOR STRESS P.S.F.	WATER CONTENT, % INITIAL	WATER CONTENT, % FINAL	DEGREE OF SATURATION, % INITIAL	DEGREE OF SATURATION, % FINAL	AXIAL STRAIN %
1	5	K	50' TO 51'	Q	5760	7100	52	-	-	-	10.0

TEST TYPE
"Q"-UNCONSOLIDATED, UNDRAINED

WALTER LUM ASSOCIATES, INC.

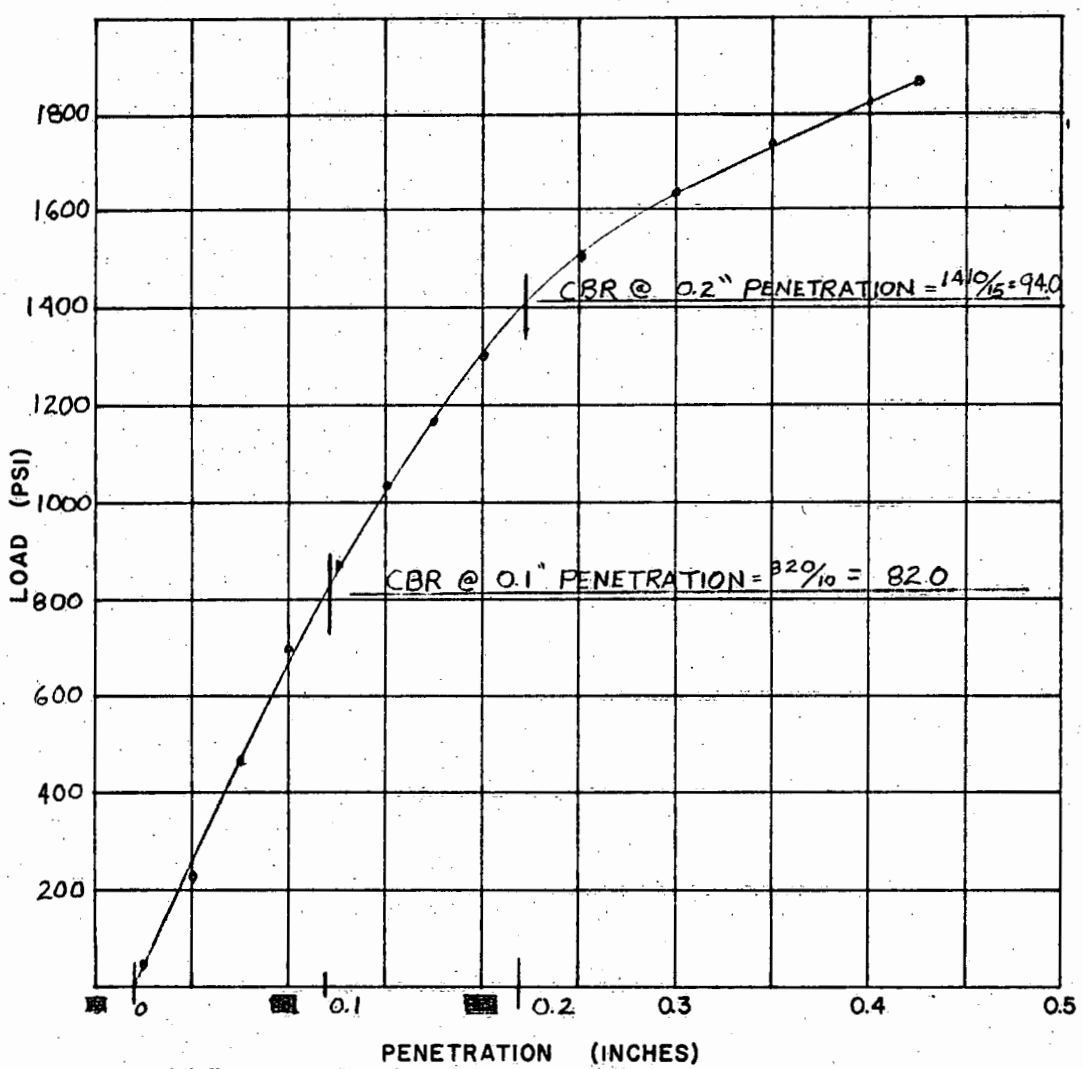
CBR TEST

PROJECT: KILI DRIVE BRIDGE

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

SAMPLE NO: 4 SURFACE

SAMPLE DESCRIPTION: BROWN CLAYEY SAND W/GRAVEL



ADJUSTED COORDINATES

CBR PENETRATION DATA

PENETRATION (INCHES)	LOAD (LBS.)	LOAD (PSI)
0.025	150	50
0.050	650	217
0.075	1380	460
0.100	2050	683
0.125	2620	873
0.150	3080	1027
0.175	3510	1170
0.200	3880	1293
0.250	4510	1503
0.300	4880	1627
0.350	5180	1727
0.400	5480	1827
~~0.450~~ 0.425	5590	1863
0.500		

AGGREGATE 3/4" MINUS

HAMMER WEIGHT 10 LBS

HAMMER DROP 18 INS

No. OF BLOWS 25/LAYER

No. OF LAYERS 5

TEST RESULTS:

MOLDING MOISTURE, %. 13.7

MOLDING DRY DENSITY, P.C.F. 124.8

CBR @ 0.1" PENETRATION 82.0

DAYS SOAKED 5

DATE 11-20-74 BY RM

DATE 11-25-74 BY RH

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

R/W

92'-0"

R/W

EXIST. KILI DRIVE (24')

TEMPORARY CULVERTS
E REMOVED (5-48"RCP)

EW SMH
A. 16+75

D_{1B}

B-1

B-2

ABUTMENT "B"

270'00'

18

OPEN

EXIST. SMH 2 (STA. 15+75)
TO BE REMOVED

B-3

B-4

CONC. PIERS

15

ABUTMENT "A"

B-5

B-6

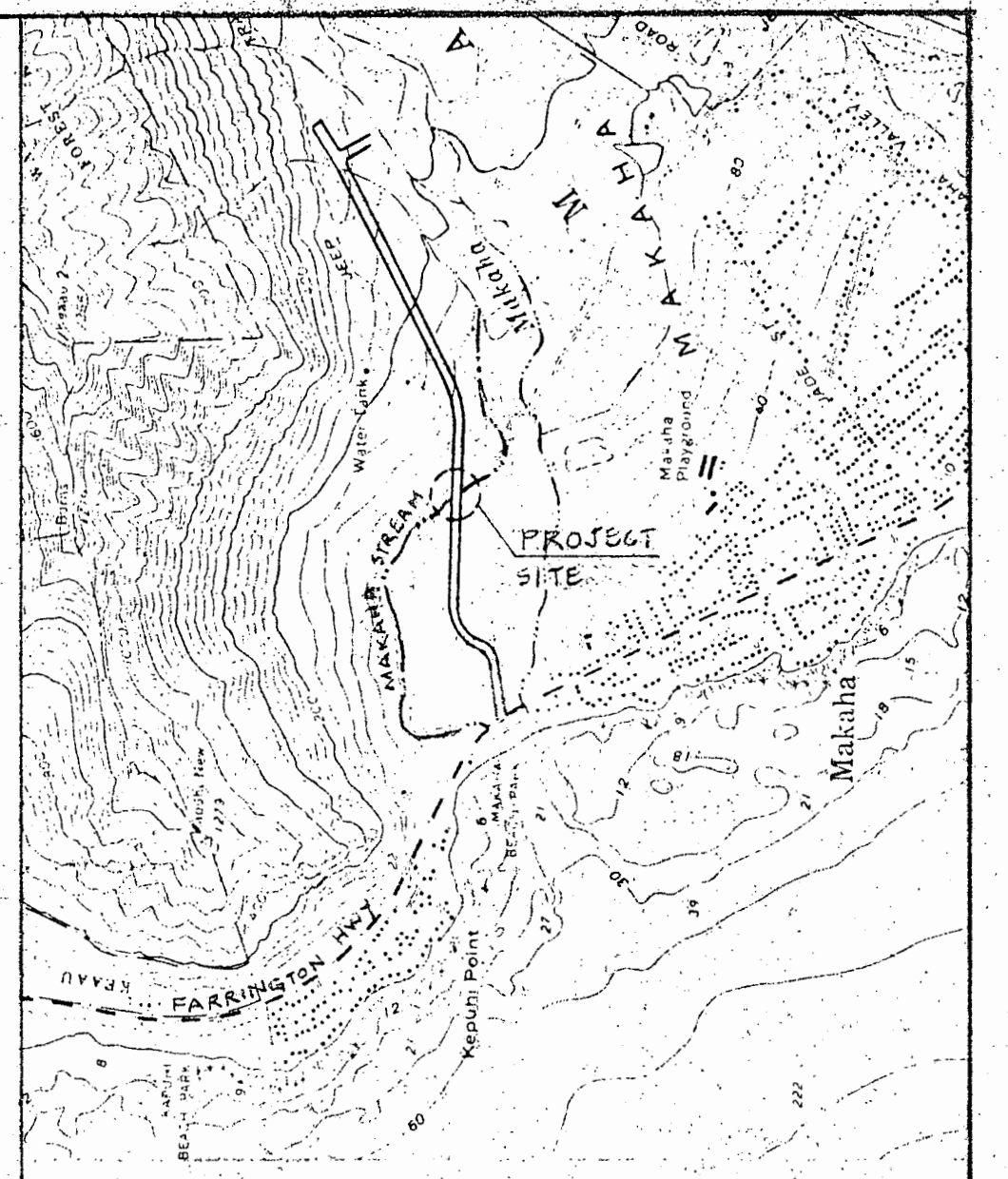
TRUE NORTH

SIXTH
TEE

MAKAHA WEST
GOLF COURSE

FIFTH
GREEN

O.B.



PROJECT LOCATION SKETCH
NOT TO SCALE

MAKAHA WEST
GOLF COURSE

FIFTH
GREEN

B-1

B-2

B-3

B-4

B-5

B-6

ABUTMENT "B"

ABUTMENT "A"

EXIST. SMH 2 (STA. 15+75)
TO BE REMOVED

CONC. PIERS

EW SMH
TA. 14+25

27'-0"

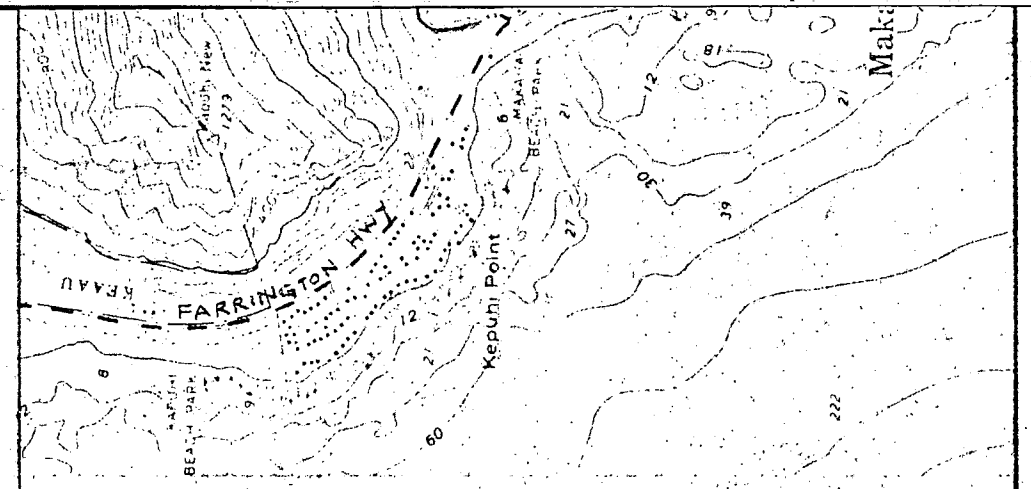
OPEN

36

32

24'
ROAD

24'
ROAD



PROJECT LOCATION SKETCH
NOT TO SCALE

BORING LOCATION SKETCH
KILI DRIVE BRIDGE
MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

Dr.	WALTER LUM ASSOCIATES, INC.	Sheet
Date 1/75	3030 WAIALAE AVE.	
Rev.	CIVIL ENGINEERS	of
	PHONE 737-7931	

LIMITATIONS

In general, soil formations are commonly erratic and rarely uniform or regular. The boring logs indicate the approximate subsurface soil conditions encountered only at the drill holes where the borings were made at the times designated on the logs and may not represent conditions at other locations or at other dates. Soil conditions and water levels may change with the passage of time and construction methods or improvements at the site.

During construction, should subsurface conditions much different from those in the borings be observed, encountered, or otherwise indicated, we should be advised immediately to review or reconsider our recommendations in light of the new developments.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes, plan changes, or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the recommendations considering the time lapse, changed conditions, and changes in the state of the art of soil engineering.

Our professional services were performed, findings obtained and recommendations prepared in accordance with generally accepted engineering practices. This warranty is in lieu of all other warranties expressed or implied.